Consumer Preference Quality Attributes of Melon Fruits

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Abstract

Sweet melons (*Cucumis melo* L. plus *Citrullus lanatus* L.) are the most popular fresh fruit, based on per capita consumption, in the U.S.A. *Cucumis melo* (muskmelons) are the only fruits in the U.S.A. to have a 2.3 fold increase in consumer demand over the past 35 years. Preference attributes expressed by consumer panelists of whole, fully mature muskmelon cultivars, following harvest and commercial storage, evaluated for appearance, color, flavor, odor, sweetness, texture, and overall acceptability are highly discernable for specific sensory attributes. Muskmelon attributes that correlated most strongly with overall fruit acceptability were flavor (r = 0.97) coupled with fruit sweetness (r = 0.97**) followed closely by fruit texture (r = 0.95**). Flavor was highly correlated with fruit sweetness (r = 0.99**) and fruit sweetness was highly correlated with soluble solids concentration (r = 0.61**). Fruit flavor is the first quality attributes to be altered during whole muskmelon fruit storage, and in the now popular fresh-cut product. Maintaining desirable muskmelon fruit sensory attributes along with microbial safety and human wellness compounds (e.g. β-carotene, folic acid, vitamin C, and potassium) in whole as well as fresh-cut fruit throughout distribution and marketing is a challenge. But these attributes can be managed through cultivar selection (orange-flesh honey dew better than orange-fleshed netted melon), production location (clay better than sandy soil), enclosed in plastic, and storage temperatures (4°C better than 10°C).**

INTRODUCTION

Per capita consumption of sweet melon fruits (*C. melo* and *C. lanatus*) in the United States currently ranks first among the most consumed fresh fruits (Table 1). In less than ten years, melons claimed the number one spot from bananas (*Musa acuminata* and *M. balbisiana*) in per capita consumption (Lester, 1997) to currently having a 3% greater consumption advantage. One possible reason for melons having such a favored position by U.S. consumers is likely due to increased consumer awareness of the many health benefits of melons (Table 2). Compared to nine other highly consumed fresh fruits, melons ranked first in Dietary Reference Intake (DRI) for β-carotene (pro vitamin A) content, ranked within the top three fresh fruits for DRI of Ascorbic acid (vitamin C) and potassium (K) contents, and ranked within the top four fresh fruits for DRI of folic acid (Vitamin B9) content. These dietary compounds are particularly beneficial in promoting human wellness. Beta-carotene is specifically helpful to the immune system as a powerful antioxidant associated with destroying cancers, reducing heart attack, stroke, cardiovascular disease, chronic fatigue syndrome, lupus, and is necessary in fighting night blindness and cataracts (Lester, 2006). Ascorbic acid has been linked with maintaining a healthy immune system, reducing the severity of colds, is a powerful antioxidant, and aids in preventing of cardiovascular disease (Lester, 2006). Folic acid directs amino acids in protein chain creation, reducing homocystine a compound involved in cardiovascular disease, is involved in cell division, regulating the central nervous system, mood, sleep, and appetite, and is linked as critical in preventing spina bifida in new born children (Lester, 2006). Potassium is a health promoting electrolyte, critical in insulin secretion, reducing high blood pressure, coronary heart disease, stroke and reducing hardening of the arteries (Lester and Crosby, 2002).

A second probable reason, and likely the most important reason, consumers like melon fruits for their highly preferred flavor, taste, and texture (Table 3). A consumer preference survey of numerous melon cultivars compared for eight sensory attributes and four quality measurement attributes, were regressed with 'overall preference' (Lester and Shellie, 1992). Overall preference was very highly correlated with flavor and sweetness ($r = 0.97$, $P < 0.001$) and texture ($r = 0.95$, $P < 0.001$) (Table 3). These correlations indicate that flavor, sweetness and texture are factors that consumer highly favored in melons and contribute to returned melon fruit purchases. Improvement/maintenance of melon preference and quality attributes can occur by selecting specific melon genotypes grown under particular cultural conditions and by marketing fruits of a specific size from particular postharvest shipping and storage conditions.

PRE AND POSTHARVEST FACTORS AFFECTING MELON QUALITY ATTRIBUTES

Soil Type and Fruit Size Influence Melon Fruit Nutritional Content

Comparison of many different cultivars of orange-fleshed netted muskmelon (Lester and Eischen, 1996) and honey dew melon (Lester and Crosby, 2002) demonstrated that phytonutrients ascorbic acid, β-carotene, folic acid and potassium are significantly affected by genotype (data not shown) and fruit size and soil type (Fig 1). Ascorbic acid, β-carotene, folic acid and potassium were lowest in concentration in the smallest fruits (commercial size 9 s or 30 s), but increased in content with increasing fruit size up to a maximum fruit size (commercial size 5 s or 12 s), then decreased with increasing fruit size. This increased concentration pattern with increasing fruit size was more pronounced in fruit produced in clay compared to sandy soils. Melon fruits with the highest nutritional content, year to year, were found in larger melon sizes from plants grown on clay soils.

Soil Type and Fruit Size Influence Melon Fruit Sensory Attributes

Sensory attributes of melons grown on clay versus sandy soils compared for desirable consumer sensory attributes (fruity and sweet aromas, and sweet taste) and undesirable sensory attributes (musty and fermented aromas, and sour taste) were significantly affected by soil type (Table 4). Melons from plants grown on clay compared to sandy soil had significantly higher desirable sensory attributes (Bett-Garber et al., 2005). Whereas, melons from plants grown on sand compared to clay had significantly higher undesirable sensory attributes. This suggests that soil texture influences melon fruit aroma and taste.

Harvest Date Affects Melon Fruit Nutrient Contents and Integrity

During melon production, fruit harvest can span a number of weeks as fruit from different pollination dates reach harvestable maturity. Multiple harvests of the same field occur over the harvest season, causing plant stress along with accumulated heat units. Fruits harvested, or fruits which ripen first (early) vs. those which ripen last (late), during a production season were found to have the highest ascorbic acid and β-carotene contents and likely higher overall quality (Fig. 2). Late harvested fruits were found to be significantly higher in malondialdehyde (MDA) than early maturing fruit; MDA is an indicator compound of melon fruit breakdown and reduced marketable shelf-life (Hodges and Lester, 2006).

Sensory Attributes Following Traditional Melon Fruit Storage

Sensory attributes of netted orange-flesh melons stored for 0, 7 or 10 days at 4°C and assayed for desirable consumer sensory attributes (fruity and sweet aromas, and sweet taste) and undesirable sensory attributes (musty and fermented aromas, and sour taste) were significantly affected by storage duration (Table 5). Fruit stored for 7 days at 4ºC had both desirable and undesirable sensory attributes generally not significantly different from fruit immediately following harvest (0 days). However, 10 days at 4ºC had significantly lower desirable and significantly higher undesirable sensory attributes vs. 7 days at 4ºC, indicating that commercial storage of melons should be less than 7 days.

Sensory and Nutritional Quality Attributes Following Modified Melon Fruit Storage

Wrapping melons, either individually, or in shipping container lined with a gas permeable, moisture retaining polyethylene film (plastic wrap) can preserve the sensory and nutritional quality attributes of melon by up to two weeks compared to bare fruit (Lester and Turley, 1990). Melon fruit enclosed in plastic wrap vs. bare fruit had significantly higher concentrations of human wellness compounds (Fig. 3) and better sensory attributes (Fig. 4) following 14 and 28 days storage at 4ºC. This technology allows for greater storage duration, e.g. surface shipment to foreign markets, while maintaining consumer preferred quality attributes.

FUTURE MARKETING ADVANTAGES FOR RETAIL CHAINS

Current and future consumer demands for melons will include sustained or improved concentration of human wellness compounds and sensory attributes, along with a reduced potential for microbial contamination either as a whole or as a fresh-cut fruit product. Replacing netted cantaloupe (*C. melo* L. reticulatus group) with orange-flesh honey dew (*C. melo* L. inodorous group) provides the processor and the consuming public with a sweeter, nutritionally richer (Table 6), superior tasting (Table 7), and microbe-safer product (Table 8). Reduced potential for microbial contamination along with a nutritionally rich melon product, especially in the ever increasing fresh-cut market, are important sales attributes that retail chains can use to both inform the consuming public and increase demand for this highly popular fruit (Saftner et al., 2006).

Literature Cited

Bett-Garber, K.L., Lamikanra, O., Lester. G.E., Ingram, D.A. and Watson, M.A. 2005. Influence of soil type and storage conditions on sensory qualities of fresh-cut cantaloupe (*Cucumis melo*). J. Sci. Food Agric. 85: 825-830.

Hodges, D.M. and Lester, G.E. 2006. Comparisons between orange- and green-fleshed non-netted and orange-fleshed netted muskmelons: antioxidant changes following different harvest and storage periods. J. Amer. Soc. Hort. Sci. 131: 110-117.

Lester, G.E. 1997. Melon (*Cucumis melo* L.) fruit nutritional quality and health functionality. HortTechnology 7: 222-227.

Lester, G.E. 2006. Environmental regulation of human health nutrients (ascorbic acid, β-carotene, and folic acid) in fruits and vegetables. HortScience 41: 3-7.

Lester, G.E. and Crosby, K.M. 2002. Ascorbic acid, folic acid, and potassium content in postharvest green-flesh honeydew muskmelons: influence of cultivar, fruit size, soil type, and year. J. Amer. Soc. Hort. Sci. 127: 843-847.

Lester, G.E. and Eischen. 1996. Beta-carotene content of postharvest orange-fleshed muskmelon fruit: effect of cultivar, growing location and fruit size. Plt. Foods Human Nutri. 49: 191-197.

Lester, G.E. and Shellie, K.C. 1992. Postharvest sensory and physicochemical attributes of honey dew melon fruits. HortScience 27: 1012-1014.

Lester, G.E. and Turley, R.M. 1990. Chemical, physical and sensory comparisons of shrink-wrapped and non-wrapped netted muskmelon fruits during storage. J. Rio Grande Valley Hort. Soc. 43: 79-84.

Saftner, R., Abbott, J.A., Lester, G. and Vinyard, D. 2006. Sensory and analytical comparison of orange-fleshed honeydew to cantaloupe and green-fleshed honeydew for fresh-cut chunks. Postharvest Biol. Technol. (in press).

Tables

Table 1. United States farm gate consumption of fresh fruit for 2004[z].

Fruit	Kg per capita
Apples	7.5
Avocados	1.0
Bananas	11.8
Citrus	10.8
Grapes	3.4
Muskmelons	**12.1**
Peaches	2.3
Pears	1.4
Pineapples	1.9
Strawberries	2.2

[z] source: www.ers.usda.gov.

Table 2. Percent daily dietary reference intake per 236 g FW[z].

Fruit	β-carotene	Ascorbic acid	Folic acid	Potassium
Apples	5	16	2	5
Avocados	2	25	52	26
Bananas	9	39	12	18
Grapes	5	16	1	10
Muskmelons	**160**	**131**	**13**	**13**
Oranges	9	197	18	7
Peaches	35	16	2	10
Pears	1	16	4	6
Pineapple	4	67	9	6
Strawberries	3	232	14	8

[z] source: www.nal.usda.gov/fnic/foodcomp.

Table 3. Consumer preference ratings of *Cucumis melo* L fruit[z].

Sensory attribute	Overall preference	Flavor rating	SSC[y] % at harvest
Flavor	0.97[**x]		0.61[**]
Sweetness	0.97[**]	0.99[**]	0.60[**]
Texture	0.95[**]	0.95[**]	
Fruit shape	0.75[**]		
Rind color	0.71[**]		
Fruit size	0.59[**]		
Cavity size	0.51[**]		

[z] source: Lester & Shellie, 1992.
[y] SSC = soluble solids concentration
[x] ** Significant at $P \leq 0.01$.

Table 4. Sensory attributes of *Cucumis melo* L fruit grown on clay vs. sandy soil[z]

Soil texture	Melon taste[y]	Sweet aroma[x]	Sweet taste	Musty aroma[w]	Sour taste	Fermented aroma[v]
Clay	3.7 a	2.3 a	5.4 a	0.5 b	0.3 b	0.1 b
Sand	3.4 a	1.7 b	4.5 b	0.8 a	0.4 a	0.2 a

[z] Source: Bett-Garber et al., 2005.
[y] Taste associated with muskmelons.
[x] Aroma associated with sweet e.g. honey
[w] Aroma associated with mould.
[v] Aroma associated with alcohol.

Table 5. Sensory attributes of *Cucumis melo* L fruit following cold storage[z].

Days at 4 °C	Melon taste[y]	Sweet aroma	Sweet taste	Musty aroma	Sour taste	Fermented aroma
0	4.2 a	2.2 a	5.9 a	1.0 a	0.2 b	0.1 b
7	4.0 a	1.9 b	4.9 a	0.6 a	0.3 b	0.0 b
10	2.7 b	1.5 c	5.0 a	0.5 a	1.0 a	0.3 a

[z] Source: Bett-Garber et al., 2005.
[y] See table 4 for description of sensory attributes.

Table 6. Soluble solids concentration (SSC), ascorbic acid and β-carotene of different *Cucumis melo* L genotypes.

Genotype	Flesh type	SSC at commercial harvest[z]	SSC at abscission (full-slip)[z]	Ascorbic acid $\mu mol \cdot g^{-1}$ FW[y]	β-carotene $nmol \cdot g^{-1}$ FW[y]
Cantaloupe	Orange	8.0 c	7.9 b	1.98 a	30.3 b
Honey dew	Green	9.2 bc	12.2 a	1.91 b	0.0 c
Honey dew	Orange	10.6 ab	11.0 a	1.90 b	53.2 a

[z] Source Saftner et al., 2006.
[y]Source Hodges and Lester, 2006.

Table 7. Sensory attributes of *Cucumis melo* L genotypes as a fresh-cut product[z].

Genotype	Flesh type	Texture acceptance	Flavor acceptance	Overall eating quality
Cantaloupe	Orange	61.8 b	63.3 a	63.6 ab
Honey dew	Green	62.9 b	58.5 b	61.4 b
Honey dew	Orange	72.2 a	69.4 a	70.2 a

[z] Source Saftner et al., 2006.

Table 8. Microbial quality [log CFU $(25g)^{-1}$] of different *Cucumis melo* L genotypes stored at 4°C as a fresh-cut product for different lengths of time (days).

Genotype	Flesh type	Day 0	Day 7	Day 10
Cantaloupe	Orange	< 3.0	4.3	5.8 a
Honey dew	Green	< 3.0	< 3.0	3.2 b
Honey dew	Orange	< 3.0	< 3.0	3.2 b

Figures

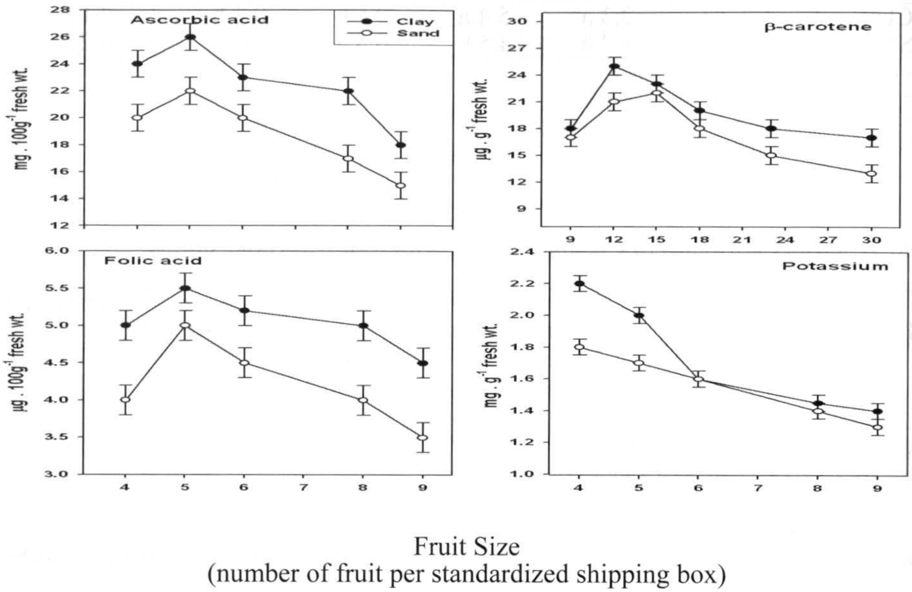

Fig. 1. Soil type and fruit size influence on nutritional quality of *Cucumis melon* L. Fruit.

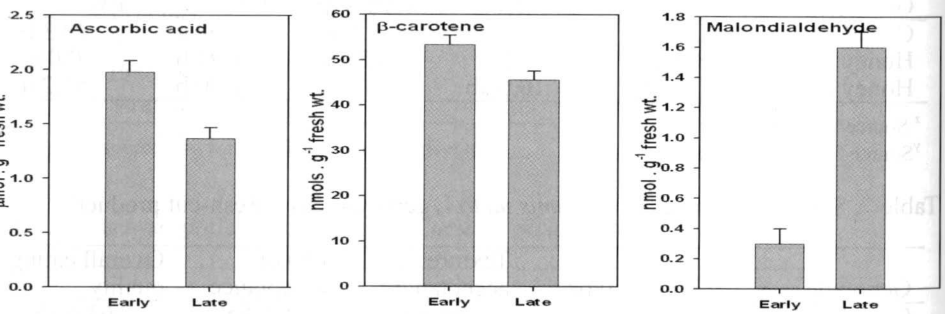

Fig. 2. Influence of harvest time (early = beginning and late = ending of the harvest season).

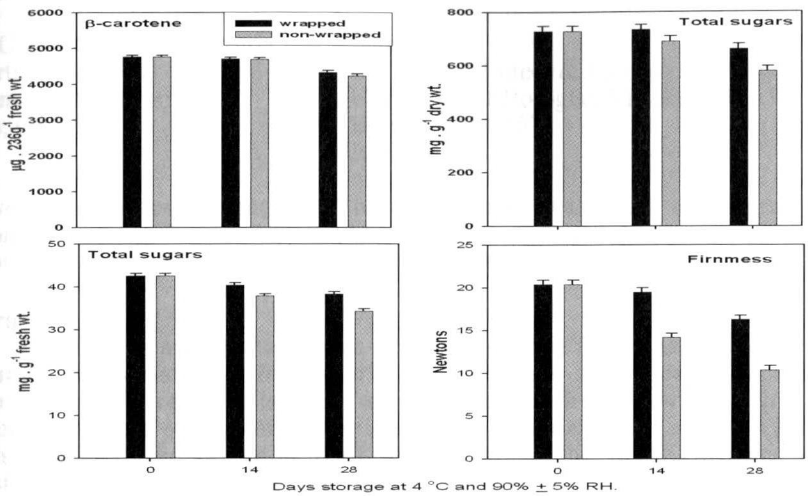

Fig. 3. Compositional analyses of melon fruit stored in a modified atmosphere (wrapped) or in conventional storage conditions (non-wrapped).

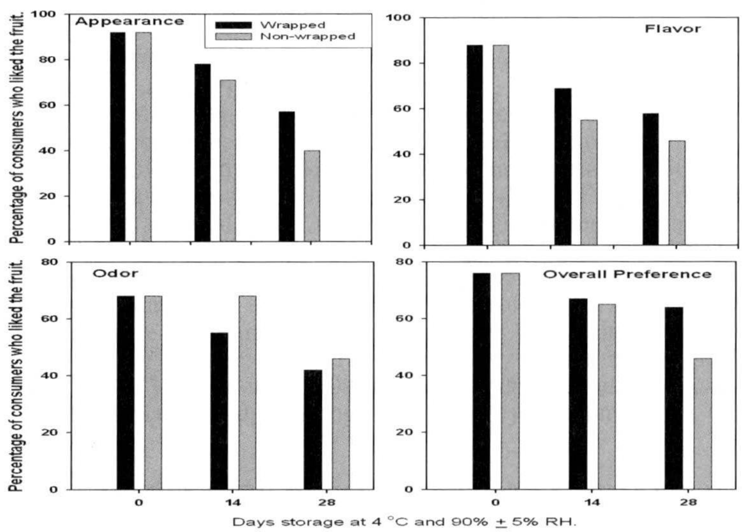

Fig. 4. Sensory analyses of melon fruit stored in modified atmosphere (wrapped) or in conventional storage conditions (non-wrapped).